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(71)(72) Applicant and Inventor: DESAI, Ashvin, H. [US/US]; 2195 Trade Zone Boulevard, San Jose, CA 95131 (US).

(74) Agent: JAFFER, David, H.; Rosenblum, Parish & Isaacs, PC, 15th floor, 160 W. Santa Clara Street, San Jose, CA 95113 (US).

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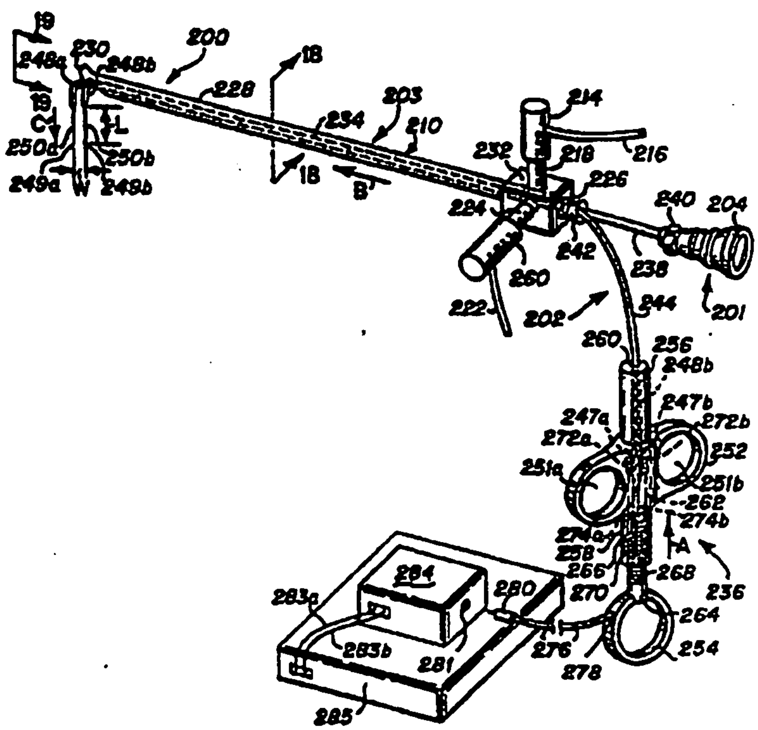
(54) Title: ENDOSCOPIC SURGICAL INSTRUMENT

(57) Abstract

An endoscopic surgical instrument (201) includes a housing (210), a single access conduit (212) formed in the housing (210), an irrigation port, and an evacuation port, each port being connected through independent valves to the single access conduit (212). The single access conduit (212) has a first end and a second end which is terminated in an aperture formed in the housing (210). A closure is provided for the aperture. A viewing device, such as an endoscope, is insertable through the aperture and the single access conduit (212), and is extended slightly beyond the first end. An electrode assembly (202) having two or more retractable RF electrodes spaced a predetermined distance and angle apart, is also insertable through the aperture and the single access conduit (212), and is extendable beyond the first end. Each RF electrode is in electrical communication with a means for supplying RF energy and for continuously measuring impedance across the electrodes.



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Specification

ENDOSCOPIC SURGICAL INSTRUMENT

RELATED CASES

This application is a continuation-in-part of my co-pending U.S. Patent Application serial No. 08/025,003, filed March 2, 1993 which is a continuation-in-part of my co-pending U.S. Patent Application Serial No. 07/779,108 filed October 18, 1991.

BACKGROUND OF THE INVENTION

Field of the Invention

This invention relates to a surgical instrument and more particularly to an instrument with the capability for continuous irrigation and evacuation of fluid into and out from a body cavity of a patient during Laparoscopic or Endoscopic surgical procedures, and for the simultaneous measurement of tissue impedance and the ablation of tissue with fixed or retractable electrodes using R.F. energy.

Brief Description of the Prior Art

Laparoscopic/endoscopic surgical procedure allows a surgeon to see inside the body cavity of a patient without the necessity of large incisions. This reduces the chances of infection and other complications related to large incisions. The endoscope further allows the surgeon to manipulate microsurgical instruments without impeding the surgeon's view of the area under consideration.

During these surgical procedures it is desirable for as few lines as possible to enter the body of the patient. This reduces the size of the incision the surgeon needs to make. It follows from this that the greater the number of functions provided by a single instrument or the greater the number of instruments able to be passed through a single line entering the patient's body, the better.

Furthermore, in certain procedures it may be desirable to irrigate the area under consideration. This in turn necessitates the evacuation of the irrigation fluid or,

when bleeding has occurred, the blood or smoke or tissue residue generated by the surgical procedure.

From what has been said above it should be apparent that it is preferable for both irrigation and evacuation to be conducted along a single conduit which, also, acts as an access line for surgical instruments.

A typical device which is used in endoscopic procedures is an electrosurgical probe. Typically such a probe will comprise a radio frequency (i.e. R.F.) energy conductive tube covered with a dielectric material such as polyolefin or Teflon. At one end, for convenience called the operational end, each probe could have any one of a number of functionally shaped monopolar or bipolar electrodes. In addition a probe could have its end formed specifically for irrigation and/or evacuation.

Monopolar and bipolar electrode probes are known in the prior art. Monopolar electrode probes include a single active electrode which is surgically introduced into a body cavity and engagable with and insertable into a tissue portion of the cavity. A passive electrode is attached to the outer body surface of the patient, e.g. typically a conducting plate is adhesively attached to the patient's leg. The body of the patient serves to complete the electrical circuit. Tissue ablation and coagulation is achieved by introducing sufficient power into the active electrode. Bipolar electrode probes include both active and passive electrodes which are similarly introduced together into the body cavity and are spaced apart from each other by a predetermined distance. Each electrode is engageable with and insertable into the tissue portion. Thus, the electrical circuit is completed by the body tissue disposed between the active and the passive electrodes and only the body tissue disposed between the two electrodes get coagulated.

Furthermore, any valves controlling the evacuation and irrigation procedures should be constructed so as to minimize the possibility of the valve malfunctions if, for example, any tissue or blood coagulates around their

moving parts. Similarly if any of the instrumentation is to be reusable, such instrumentation, including the valves, should be capable of being efficiently cleaned by, for example, flushing.

United States Patent 4,668,215 (Allgood) discloses a valve for switching between an evacuation and an irrigation conduit and allowing both such evacuation and irrigation to be done via a single line entering the patient. The mechanism for switching between the irrigation, evacuation and closed configurations is by means of a L-valve or T-valve. This patent, in another embodiment thereof, further provides for a piston valve for making an on-off connection between an evacuation port and the line leading into the patient.

The L- and T-valves have the disadvantage that they must be manipulated by rotation by the surgeon, usually using his/her free hand. The piston valve disclosed in this patent has the disadvantage that it has many areas where blood and tissue accumulation and coagulation can occur which may result in the malfunctioning of the valve. In addition, the piston valve has numerous "dead" areas where fluid flow would not occur. This precludes the device from being effectively cleaned by commonly used flushing techniques. Finally, the Allgood patent does not disclose a single body for housing an evacuation/irrigation control valve together with a housing for laparoscopic and microsurgical instrumentation.

A surgical valve that the applicant is aware of is the piston valve illustrated in Fig. 1 of the accompanying drawings.

In this valve a piston 10 is located within a cylinder 11. The piston 10 can be moved along the bore of the cylinder 11 by means of a plunger 12, from a closed position (as shown) to an open position in which a conduit 13 is aligned with an access port 14. This allows fluid flow along a path to or from access port 14, via conduit 13 and space 16 from or to a further port 15. Upon

release of the plunger 12 the piston 10 returns to its closed position under action of a spring 17.

This valve, although easy to use, has the disadvantage that blood and tissue accumulation occurs in space 16 and clogs both the space and the spring 17. This may result in undesirable over-evacuation or irrigation of the patient during surgical procedures.

OBJECTS OF THE INVENTION

It is therefore an object of this invention to provide a surgical instrument which includes control means to allow for the continuous irrigation and evacuation of a body cavity of a patient during microsurgical procedures, with both irrigation and evacuation being performed along a single line into the patient. The instrument should also act as a mounting for electrosurgical probes and microsurgical instruments.

A further object of the invention is to provide a configuration for an instrument which, depending on the material it is constructed of, can be both disposable and non-disposable. In the event that the instrument is "reusable" or "reposable" it is an object of the invention to provide the instrument with conduits, access ports and valves which can easily be cleaned by means of commonly used cleaning techniques and conventional sterilization methods.

It is another object of the invention to provide an electrosurgical instrument with fixed or retractable RF electrodes having the capability to simultaneously perform controlled ablation of tissue using monopolar/bipolar R.F. energy and precise measurement of tissue impedance.

SUMMARY OF THE INVENTION

According to this invention, an endoscopic surgical instrument comprises an irrigation and an evacuation port, each port being connected through independent valves to a single access conduit; a probe connector located at one end of the access conduit, the probe connector being for receiving and retaining a hollow surgical probe; and a

monopolar or bipolar radio frequency connector which exits into the access conduit in such a manner so as to make radio frequency connection with a probe received by the probe connector.

Preferably the connector for receiving an end, for convenience called the locating end, of the probe would be in the form of a receiving bore in the access conduit which would include a plurality of O-rings which provide a fluid-tight seal around the locating end of the probe. These O-rings also function to retain the probe in the receiving port while allowing the probe to be rotated. In one embodiment of the invention, the O-rings are, instead of being located within the receiving bore of the access conduit, located about the locating end of the probe.

This invention also provides for a valve, for use as either an evacuation or an irrigation valve, the valve comprising a housing, an activator connected to the housing, at least a first and a second valve access conduit, both of which exit into the housing and a fluid impervious seal mounted within the housing such that activation of the activator causes the first valve conduit to move axially relative to the seal and the second valve conduit such that the seal is disengaged and the conduits are placed in direct fluid communication with each other.

Typically, the instrument of the invention would contain two of the above described valves. One valve would act as an evacuator control while the other valve would act as an irrigation control. Both valves communicate into a single access conduit which, when the instrument is in use, continuously flows into the patient via the receiving bore and the hollow interior of the electrostatic probe.

Preferably the endoscopic surgical instrument of the invention is in the form of a pistol with the "barrel" portion thereof having, at one end thereof, the receiving bore for the locating end of the endoscopic probe and, at the other end thereof, the access port for the microsurgical instruments and endoscopes.

The valves for controlling the evacuation and irrigation procedures may be mounted in the "handle" portion of the pistolshaped instrument. The valves may be mounted alongside one another in the handle portion and may protrude therefrom to allow finger control by the surgeon using the instrument.

In one alternate embodiment of the invention the surgical instrument includes a housing, a single access conduit formed in the housing, an irrigation port and an evacuation port, each port being connected through independent valves to the single access conduit. The single access conduit has a first end, and a second end which is terminated in an aperture formed in the housing. A closure is provided for the aperture. A viewing device, such as an endoscope, is insertable through the aperture and into the single access conduit. The viewing device is of sufficient length such that it is extendable slightly beyond the first end. A retractable electrode assembly is also insertable through the aperture and into the single access conduit, and is of sufficient length such that it, too, is extendable beyond the first end. The retractable electrode assembly, in one embodiment, includes two retractable RF electrodes spaced apart by a predetermined width. Each RF electrode is made from a superelastic material, e.g. typically Nickel-Titanium (NiTi) metal, is sheathed within a guiding sheath, and is slidable within the sheath such that it is extendable beyond and retractable completely within the sheath. Also, each electrode is connected to a mechanism, operable by a surgeon, for moving the electrode within the sheath. Each electrode is extendable beyond its guiding sheath by a variable length and at a predetermined angle from a longitudinal axis of the single access conduit. Further, each electrode is electrically communicative with means for supplying R.F. energy and means for measuring impedance continuously on a realtime basis.

These and other objects and advantages of the present invention will no doubt become apparent to those skilled

in the art after having read the following detailed description of the preferred embodiment which is illustrated in the several figures of the drawing.

IN THE DRAWINGS

In the following drawings:

FIG. 1 is a partial sectional elevation through a prior art piston valve;

FIG. 2 is a diagrammatic section through a semi-exploded elevation of one embodiment of the endoscopic surgical instrument of the invention;

FIG. 3 is an illustration of a tricuspid valved access port illustrated in plan (a) and elevation (b) views;

FIG. 4 is a section through a receiving bore of the instrument illustrating one way of locating a probe in the bore;

FIG. 5 is a section through a similar receiving bore showing a different way of locating a probe in the bore;

FIG. 6 is a side view illustrating in (a)-(i) various electrostatic probe operational ends;

FIG. 7 is a section through a valve according to the invention with the valve being in the shut position;

FIG. 8 is the valve of FIG. 7 in the open position;

FIG. 9 is a partial section through a different type of valve also suitable for use in the instrument of the invention;

FIGS. 10, 11, 12 and 13 are diagrammatic illustrations showing various configurations of valve operating buttons and triggers;

FIG. 14 is an exploded view of an alternative embodiment of the surgical instrument of the invention illustrating a disposable valve cartridge;

FIG. 15 is a cross section through the disposable valve cartridge illustrated in Fig. 14;

FIG. 16 is a partially sectioned view of another type of valve which can be used in the surgical instrument of the invention;

FIG. 17 is a perspective view of an alternate embodiment of the endoscopic surgical instrument having generally

similar valves, as illustrated in FIG. 7-8, and a retractable electrode assembly having bipolar RF electrodes in electrical communication with a R.F. energy source and a tissue impedance monitoring device;

FIG. 18 is a partial sectional view taken along the line 18-18 of FIG. 17;

FIG. 19 is a view taken along the line 19-19 of FIG. 17;

FIG. 20 is a side elevation view of the retractable electrode assembly shown in FIG. 17;

FIG. 21 is an enlarged view of the tip of the retractable electrode assembly shown in FIG. 17;

FIG. 22A-22H illustrate alternate electrode configurations for the retractable electrode assembly shown in FIG. 17 and 20;

FIG. 23 is an enlarged view of the tip of the retractable electrode shown in FIG. 22D-22F; and

FIG. 24 is an alternate embodiment of the present invention including a retractable electrode assembly having a variable angle control mechanism.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

In FIG. 2 of the accompanying drawings, the endoscopic surgical instrument of the invention is generally indicated as 20. The instrument 20 is shown to include an irrigation port 21 and an evacuation port 22. Each port, 21 and 22, is connected through independent valves 23 and 24, respectively, to a single access conduit 25. The connection between the valves 23 and 24 and conduit 25 is along connector tubes 23a and 24a.

The access conduit 25 leads from the valves and their respective valve conduits to a probe connector 26. This probe connector 26 is designed to receive one end, the locating end 27, of a surgical probe 28 which would be used during microsurgical procedures. The connection 26 is described in more detail with reference to FIGS. 4 and 5 hereafter.

At or near the probe connector 26, a monopolar/bipolar radio frequency connector 29 is located. As illustrated,

this is in the form of a R.F. connector. The advantage of a R.F. connector is that it is an industry standard and can be used for connecting the instrument 20 to standard R.F. energy sources marketed by a number of different manufacturers.

The radio frequency connector 29 exits into the access conduit 25 where it makes connection with a point 30, on the locating end 27 of a probe 28 received by the probe connector 26.

The surgical instrument 20 also includes a port 31 which allows the surgeon to insert microsurgical instrumentation and viewing devices along the access conduit 25 and the bore of the hollow probe 28 to exit from the end 32 thereof. The port 31 should provide a fluid-tight seal when no microsurgical instrumentation is being used with the surgical instrument 20. This will prevent fluid, which may be moving along the access conduit 25 to or from the patient, from leaking.

Typically, the access port 31 is in the form of a commercially available tricuspid valve as illustrated in FIGS. 3(a) and (b). In these figures, the valve 31 is shown as being constituted by three segments 32 which in plan view are wedge-shaped and which together form the disc shaped sealing portion of the valve. The segments 32 are held together by means of a circumferential ring 33 which biases the three segments 32 together to form a fluid-tight seal. In use, the microsurgical instrumentation are inserted through the valve at a point 34 where the apexes of the segments 32 come together. This insertion forces the elements of the valve apart to allow ingress of the microsurgical instrumentation. The effect thereof is shown in broken lines in FIG. 3(b). When the instrumentation is removed from the valve 31, the segments 32 are pulled together to form the seal.

In FIG. 4 the probe connector 26 is shown to be constituted by a receiving bore which is coaxial with the fluid access conduit 25. In practice, the diameter of this bore would be the same as that of the access conduit

25 and would be sized to receive the locating and 27 of the probe 28 in a relatively close fit. Within the bore forming the probe connector, a plurality, typically two, O-rings 36 are located. When the locating end 27 is inserted into the bore 26 these O-rings provide a snug, fluid-tight seal about the end 27. Once the locating end 27 of the probe is received within the bore 26 it is capable of being rotated about its longitudinal axis, by means of a knurled rotation knob 37 located between the locating end 27 and the operational end 32 of the probe 28.

The probe 28 would typically be made of a electrostatic conductive material coated with a non-conductive material such as heat shrink polyolefin or Teflon. Electrostatic/radio frequency energy is passed along the probe 28 from the radio frequency connector 29 via electrostatically conductive plates 38 located within the bore of the probe connector 26 and onto the end 30 of the probe 28. The end 30 is so designed such that when the locating end 27 of the probe is received by the probe connector 26, electrostatic connection is made between the plate 38 and the connector 30. This allows the surgeon to pass energy into the patient being operated on.

An alternative radio frequency connector is illustrated in FIG. 5. In this case, the R.F. connector 29 exits into the bore 26 in the form of a pin 39. In the conductive end 30 of the probe 28 an L-shaped slot 40 is formed. As the probe 28 is inserted into the receiving bore 26, the pin 39 engages the axially-orientated leg 41 of the L-shaped slot 40. When the probe can be inserted no further along the bore it is twisted, in this case in an anti-clockwise direction, such that the pin 39 and the axially transverse leg 42 of the L-shaped slot 40 engage each other to lock the probe 28 into position. In this embodiment the probe 28 cannot be rotated by means of the knurled knob 37.

FIG. 5 further illustrates an alternative positioning of the O-rings 36. In this case they are located on the locating end 27 of the probe 28.

From FIGS. 4 and 5, although not shown, it will be apparent that the diameter of the operational shank 28a of the probe 28 can be variable. Typically, the probe, as shown, would have a diameter of 5mm. This diameter can, however, be increased to 10mm which would be close to the diameter of the locating end 27 of the probe, as well as that of the internal bore diameter of the access conduit 25. The advantage of 10mm diameter probes is that the evacuation of removed tissue and objects such as the gall-stones can be more effectively achieved. Obviously, when the bore of the operating shank 28a of the probe, the locating end 27 and the access conduit 25 are all 10mm in diameter, the diameter of the evacuation port 22 and its related valve 24 and connector tube 24a must also be 10mm.

In FIG. 6(a) to (i), a side view of number of different electrode shapes are illustrated. It will be appreciated that the electrode tips could be either monopolar or bipolar. In the case of bipolar electrodes, only one electrode is illustrated since a second electrode is fully obscured by the visible electrode. These electrode tips would be located on the operating end of the probe 28.

As can be seen from the figure, a number of the tips are not symmetrical about the longitudinal axis of the probe 28. It is for this reason that it is desirable for the probe 28 to be mounted on the instrument in such a manner to allow for a rotation of the probe about its longitudinal axis. As has been previously indicated, this will give the surgeon the opportunity of rotating any non-symmetrical tips, inside the patient, without having to rotate his or her wrist.

This invention extends also to an electrostatic probe 28, substantially as described in any of the FIGS. 4 to 6.

The details of one type of irrigation/evacuation valve are illustrated in FIGS. 7 and 8. The valve 24 indicated in both figures comprises a housing constituted by a

hollow tube 50 and an activator in the form of a button 51 formed integrally with the tube 50. A fluid impervious seal 52 is located within the tube 50. Referring specifically to FIG. 7, in which the valve is shown in the shut position, it can be seen that the seal 52 lies between a first valve conduit 53 which leads to the evacuation port 22 (not shown) and a second valve conduit in the form of connector tube 24a which leads into the primary access conduit 25 of the surgical instrument. In effect, the seal 52 prevents the conduits 53 and 24a from being in communication with each other.

The first valve conduit 53 is mounted onto the wall of the tube 50 and opens into the interior of the tube 50 through a hole 54. Between the seal 52 and the button portion 51 of a tube 50, a spring 55 is located. On the side of the seal 52, opposite to which the spring is located, a tubular insert 56 is located. This tubular insert has a snug but slidable fit over the outer wall of the second valve conduit 24a as well as a tight, fluid impervious fit into the inner bore of the tube 50. This tube 56 acts as a stop which prevents the spring 55 from pushing the seal 52 out of the hollow tube 50.

To open the valve, as is illustrated in FIG. 8, an activating force, applied along a line F to the button 51, will cause the button to move from the position indicated in broken lines to the illustrated open-valve position. As the button moves, so does the hollow tube 50, taking the first valve conduit 53 along with it. In addition, the leading edge 57 of the second valve conduit 24a bears against the seal 52 causing the seal to move relatively to the tube 50. This in turn disengages the seal from sealing the hole 54 in the wall of the tube 50. The movement of the first valve conduit 53, relative to the second valve conduit 24a, places the respective openings 54 and 58 of these two conduits in fluid communication with each other thereby allowing an unobstructed fluid flow along both access conduits.

Upon release of the force on the button 51, the bias of the spring 55 will return the valve to its shut position.

It is evident from the construction of the valves illustrated in FIGS. 7 and 8 that they can be readily cleaned by commonly used cleaning such as flushing. In addition, the valves have almost no areas where blood and tissue accumulation and coagulation can occur, and if such accumulation and coagulation does occur the valves cannot be jammed in the open position. This is because the spring biasing the valve into its closed position is located in an effectively sealed area. Furthermore these valves have been tested to a pressure of up to 100 psi without the integrity of the valve seal being adversely affected.

An alternative form of valve, to that illustrated in FIGS. 7 and 8 above, is shown in FIG. 9. In the figure the valve is shown to include a generally cylindrical valve body 60, an activating button 61 and a plunger 62. A hollow bore runs down the center of the valve body 60 and contains the valve seal 63. The valve seal 63 is made up of a circular washer 63a and a sealing O-ring 63b and is screwed onto the bottom of plunger 62. The valve seal 63 is biased into its illustrated sealing position by means of a spring 64 located in the bottom part of the valve body 60.

To open the valve, the button 61 is depressed so that the plunger 62 forces the valve seal 63 downwards against the bias of the spring 64 to a position shown in broken lines 63', in the figure. As a result, a fluid path, indicated by arrows 65, is opened between an upper pair of cutouts 66 and a lower pair of cutouts 67. Each pair of cutouts opens into the hollow bore in the center of the valve body 60 and, when this valve is inserted into the surgical instrument, into either an evacuation or irrigation conduit. Closure of the valve is achieved by releasing the button and allowing the spring 64 to return the valve seal 63 to the sealing position.

One advantage of this embodiment of the valve is that it is easily removed from and inserted into the surgical instrument of the invention. Accordingly the valve can easily be removed for cleaning or disposal and replacement. This is further illustrated below with respect to FIG. 13. It is sufficient here to mention only that the surgical instrument is provided with a receiving bore for each valve and that the valve includes a plurality (in this case 3) O-rings 68 which, when the valve is inserted into its respective receiving bore, provide a number of fluid tight seals against the inside of the bore.

Either of the two types of valve described in FIGS.7 to 9 can be used on the instrument 10. Typically one valve would act as an evacuation valve while the other as an irrigation valve. Different types of arrangements of valves and valve activation means are illustrated in the following 4 figures.

One way of activating the valve is by means of a rocker-shaped trigger 70 illustrated in FIG. 10. The trigger 70 is pivotally mounted on a point 72 on the handle 74 of the pistol. Depressing the trigger 70 to operate the irrigation valve 71 would not interfere with the operation of the evacuation valve 73. Similarly, operation of the trigger 70 to operate the evacuation valve 73 would in no way effect the operation of the irrigation valve.

In FIG. 11 a trigger mechanism 76 is shown for operation of only one of the buttons. The other button 78 would be located for operation by means of the surgeon's thumb in a position removed from the trigger 76. This could, for example, be near the top end of the handle portion of the instrument.

Yet a further positioning of the buttons 71 and 73 is indicated in FIG. 12. In this instance, the buttons protrude from the top rear of the pistol handle and are located side-byside. To prevent confusion between evacuation and irrigation procedures, the tops of the buttons have different shapes. So, for example, the

button to manipulate the evacuation valve could be concave while the button for manipulating the irrigation valve could be convexly shaped.

FIG. 13 illustrates still another arrangement of buttons and valves, in this case an arrangement particularly suited to the valve shown in FIG. 9.

In this figure only the pistol grip 90 of the surgical instrument of the invention is shown. An irrigation port 92 and evacuation port 94 enter the pistol grip 90 at the bottom of its handle portion. The ports 92, 94 are, in use, respectively connected to irrigation and evacuation conduits (not shown) and, to this end, suitable connectors, as illustrated, are provided.

The irrigation port 93 communicates with the main access conduit 96 (referenced as 25 in FIGS. 2, 4 and 5) along an irrigation conduit 98 which extends from the irrigation port 93 and into the rear of the bore 100 which houses an irrigation valve 102. From there it extends along the bore 100 to a point near the front of the bore from where it exits into the body of the grip 900 to enter rear of the bore 104 which houses an evacuation valve 106. the irrigation conduit extends directly across the bore 104 at this point and becomes a central conduit 108 which communicates with the access conduit.

On the other hand, the evacuation port 94 communicates with an evacuation conduit 105 which extends along the pistol grip 90 directly into the front of the bore 104, down to the bore 104 to its rear from where it exits into the central conduit 108.

In the position shown, both the irrigation and evacuation valves 102, 106 respectively, are shown in the off or shut configurations and neither evacuation or irrigation can take place. Should irrigation of the patient be required, the dish-shaped irrigation button 110 is depressed and the valve 102 opens (ie. its valve seat moves to the right in the drawing) to allow irrigation fluid to pass along the irrigation conduit 98 and into the bore 104. In this bore 104 the evacuation valve 106 is in

the off configuration. However, a fluid path exists across the pair of cutouts (67 in FIG. 9) and therefore the irrigation fluid can pass through the body of the valve 106 and into the central conduit 108 and, from there, into the access conduit 96.

When evacuation is desired the irrigation button 110 is released and the spring associated with the irrigation valve 102 biases it into the shut or off configuration. Thereafter the flat topped evacuation button 112 is depressed to open the evacuation valve 106. This allows the patient to be evacuated along the main access conduit 96, into the central conduit 108, then from the rear to the front of the bore 104 and, from there, out along the evacuation conduit 105.

As has been indicated earlier, the valves 102, 106 are easily inserted into and removed from their respective bores 100, 104. This allows the pistol grip 90 (which is typically stainless steel and is reusable) to be cleaned efficiently. The valves, typically being of plastic and being difficult to clean, can be discarded and replaced with new valves.

A variation on this theme of discardable valves is illustrated in FIG. 14. In this figure the surgical instrument is shown to include a pistol grip 120, a surgical probe 122, which can be screwed into the front of the pistol grip 120 and a radio frequency connector 124 which screws into the back of the grip 120.

The instrument also includes a removable (and disposable) valve cartridge 126. The cartridge 126 includes an irrigation pipe 128 and an evacuation pipe 130 both of which are individually operated by valves (as will be further illustrated in FIG. 15) under action of button-shaped actuators 132. Both the irrigation and evacuation pipes communicate into a single conduit (not shown) which runs down the center of a male connector fitting 134. Where the cartridge 120 is inserted into the grip 120 the connector 134 fits into the base of a central conduit 136 which, in turn, opens up into the main access conduit 138

of the instrument. When the cartridge 120 is located in the grip 120 the actuators 132 are located directly below a pair of operating triggers 140 which can be used to operate the irrigation/evacuation procedures described before.

Finally, when the cartridge 120 is in place, it is held there by means of a retainer clip 142 which clips in behind the cartridge 120. The retainer clip 142 has apertures 144 formed in it to allow the irrigation and evacuation pipes 128, 130 to pass through it.

Although it will be apparent that the valve types described above are also suitable for use in the cartridge 120, a further valve configuration is illustrated in FIG. 15, which illustrates the cartridge 120 in greater detail.

In this figure, the cartridge 120 is shown to include an irrigation conduit 150 and an evacuation conduit 152, both of which lead to a central access conduit 154 which extends down the center of the male connector 134. Irrigation and evacuation procedures are controlled by irrigation and evacuation valves 156 and 158, respectively.

The irrigation valve 156 consists of a valve seal 160 mounted onto a stem which is screwed into an activator button 132a. A fluid tight seal is provided for the valve 156 by an O-ring 168 mounted onto the cap 132a. The valve seal 160 seals against a valve seat, formed at the junction between the irrigation conduit 150 and the central access conduit 154 and is held in the sealing position (as shown) by a spring 162.

Access to the valve seat is through a hole 164 formed into the top (as shown in the drawing) of the cartridge 120. This hole 164 can be closed off with a cap 166 and allows the irrigation valve 156 to be inserted into the cartridge 120. This is done by inserting the valve seal 160 and its associated stem into the hole 164 from above and inserting the spring 162 from below. Thereafter the cap 132a can be screwed onto the stem to hold the entire valve 156 in place.

To operate an irrigation procedure the button 132a is depressed to move the valve seal 160 clear of its seal to open a fluid path between the irrigation conduit and the central access conduit. Releasing the button 132a causes the spring 162 to force the seal 160 back into its seat thereby automatically shutting the valve.

The evacuation valve 158 is of a different construction. In this valve 158, the valve seal 170, in its off position as shown, seals the mouth of the evacuation conduit 152.

In operation, the seal 170 is moved under action of a plunger and evacuation button 132b from the position shown to a position 170′ in which an end of a conduit 174, formed through the seal 170, aligns with the central access conduit 154. At the same time the other end of the conduit 174 is aligned with the evacuation conduit 152 and evacuation can be accomplished. By releasing the button 132b, the spring 172 biases the seal 170 back into its sealing position.

Assembly of this evacuation valve 158 is by inserting the entire valve mechanism into its valve bore and sealing a collar 176 in the bore.

As has been indicated with reference to FIG. 14, the cartridge 120 is of the disposable type and is intended for use only once. Accordingly the considerations of valve flushing (during cleaning) are not entirely applicable here.

In FIG. 16 yet another type of valve, which can be used as either an irrigation or an evacuation valve, is illustrated.

The valve, generally indicated as 180, is shown to include a hollow cylindrical valve body 182 which is sealed at its lower end by a valve seal 184 and at the other by an activator button 186. The activator button 186 seals against the valve body with an O-ring 188 and is connected to the valve seal 184 by means of a plunger 190.

To open the valve 180, the button 186 is depressed against the bias of a spring 192 to move the valve seal 184 to the position indicated in broken lines. This opens

a fluid path 194 between an opening 196 formed in the sidewall of the valve body and its lower end. Releasing the button 186 allows the spring 192 to force the seal 184 back into the closed position.

One advantage of this valve is that it is very simple and inexpensive to manufacture and can, therefore, readily be disposed of.

Finally, it will be apparent to anyone skilled in the art, that the surgical instrument of this invention could be made from any suitable material. In the event that the instrument is intended for single use, plastic material could be used. Alternatively, for reusable or reposable instrument, the instrument can be made of a more durable material.

FIG. 17 is a perspective view of an endoscopic surgical instrument 200 which is an alternate embodiment of the surgical instrument 20 described above. FIG. 18 is a partial sectional view of a portion of the instrument 200 taken along the line 18-18 of FIG. 17 and FIG. 19 is another view of the instrument 200 taken as indicated by the line 19-19 of FIG. 17. FIG. 20 illustrates the retractable electrode assembly 202. When viewed together, FIG. 17-20, illustrate the instrument 200 including an endoscopic instrument 201, a retractable RF electrode assembly 202, an continuous irrigation and evacuation assembly 203, a R.F. energy source 285, and a tissue impedance monitoring device 284. It will be appreciated that, although two retractable RF electrodes are illustrated and subsequently described, in alternate embodiments the retractable electrode assembly could have one or more than two retractable RF electrodes. Also, although a bipolar retractable RF electrode assembly is illustrated and subsequently described, it will be appreciated that a monopolar retractable RF electrode assembly could be used.

The assembly 203 includes a housing 210, an irrigation valve assembly 214, and an evacuation valve assembly 220. The housing 210 includes an elongated portion 228 having

a generally oval cross section. The portion 228 includes a free tip end 230 and a secured end which is attached to a handle portion 232. The portion 232 is held by the surgeon, and the portion 228 is surgically introduced into a body cavity (not shown) of the patient. A single access conduit 212 (a portion of which is best seen in FIG. 18 and 19) is formed between an inner surface of the portion 228 and the objects carried within the portion 228. The conduit 212 is disposed along the entire longitudinal length of the portion 228 and is functionally similar to the conduit 25 (FIG. 2) in that it permits the irrigation and evacuation of fluids into and out from the body cavity into which the portion 228 is inserted. The conduit 212 is open at the tip end 230 and can be accessed, at its opposite end, via an aperture and associated closure 226 formed in the handle portion 232. The closure 226 is in the form of a tricuspid valve and is substantially similar to the valve 31 illustrated and described above (FIG. 2).

The irrigation valve and the evacuation valve assemblies 214, 220 are substantially similar to the irrigation and evacuation valves 23, 24 described above (FIG. 2). The valve assemblies 214, 220 operate in a similar manner to valves 23, 24 (FIG. 7, 8). Depressing the valve assemblies 214 or 220 permits the communication of fluid in a valve first conduit 216 (or 222) with a valve second conduit 218 (or 224). Each of the valve second conduits 218 and 224 are in fluid communication with the conduit 212 (in the same manner that the conduits 23a, 24a are in fluid communication with the conduit 25, FIG. 2). Thus, when the valve assembly 214 is operated, irrigation fluid can be communicated to the conduit 212 and out through the tip end 230, and delivered to the body cavity. In a similar manner, fluids in the body cavity can be evacuated if the valve assembly 220 is operated.

The retractable electrode assembly 202 includes a means for guiding the angular orientation of the electrode or guide sheath 248, an endoscope sheath 238, a electrode movement mechanism 236, a tissue impedance measurement

device 284, and a R.F. energy source 285. The sheath 248 is generally parallel to the scope sheath 238. The sheath 248 and the sheath 238 are each insertable into an opening of an insert flange 242, into the aperture of the handle portion 232 of the assembly 203. The sheath 248 and the sheath 238 are insertable within the conduit 212 and are each of sufficient length such that when each is fully inserted within the conduit 212, each extends slightly beyond the tip end 230 of the cylindrical portion 228.

The endoscopic instrument or endoscope 201 is substantially similar to the endoscope instrument described above, and can be any of a number of devices known in the prior art. An eyepiece 204 is shown attached to the endoscope 201. The endoscope 201 is slid into the scope sheath 238 until the eyepiece 204 engages a flange 240 which is attached to the sheath 238. Thus, the endoscope 201, and the sheath 248 of the retractable electrode assembly 202 are both insertable within the portion 228 of the irrigation and evacuation assembly 203.

Each of two RF electrodes 250a, 250b is sheathed within its respective guide sheath 248a, 248b. Although the illustrated embodiment depicts two RF electrodes, it will be appreciated that the assembly 202 could have one or more than two electrodes. Each electrode 250a, 250b includes a first or distal end 249a, 249b, a second, or proximal end 247a, 247b, and a central portion (not shown) disposedly connected therebetween. A coating of insulation 246 is disposed onto the bare electrode 250. The insulation coating 246 may be in the form of a tube of material (such as teflon) heat shrunk around the bare electrode 250. Alternately, the insulating coat 246 may be powder deposited, using vacuum deposition techniques, onto the bare electrode 250. In either case, nearly the entire length of the bare electrode 250 is covered by the insulating coat 246.

The electrodes 250a, 250b have a generally constant diameter throughout its entire length and are sized such that they can be slid within the sheaths 248a, 248b. That

is, there exists a sufficient clearance (e.g. 0.005 inch) between the outside diameter of each of the insulating coats 246a, 246b of the electrodes 250a, 250b and the inner diameter of the respective sheaths 248a, 248b. Each electrode 250a, 250b is made from a superelastic metal material, e.g. typically a Nickel-Titanium (NiTi) metal alloy. The guide sheaths 248a, 248b are made from a rigid plastic or coated metal tubing which forms a rigid conduit that guides, i.e. deforms, the electrode along a predetermined path.

As best seen in FIG. 19, the electrodes 250a, 250b and their respective sheaths 248a, 248b are contained within the cross sectional envelope of the portion 228. Thus, the required incision into the patient need only accommodate the cross sectional area of the portion 228. The presence of the extendable electrodes does not increase the size of the required incision. It should be also noted that each electrode 250a, 250b descends downwardly into the field of view of the endoscope 201. In this manner the surgeon is able to view the extension of each electrode 250a, 250b beyond the end of the sheath 248a, 248b.

The two electrodes 250a, 250b and their respective insulators 246a, 246b are encased within their respective guide sheaths 248a, 248b which are encased within a plastic insulating covering 244. The electrodes 250a and 250b encased within the plastic covering 244 exits the housing 232 through the opening in the flange 242.

Each electrode 250a, 250b is in parallel electrical communication with a tissue impedance measuring device 284 and a R.F. energy source 285. The covering 244 enters the movement mechanism 236 through an opening 260 formed in a sleeve 256 of the mechanism 236. The electrodes 250a, 250b and their respective insulators 246a, 246b exit from the covering 244 and each of the second ends 247a, 247b, of each of the electrodes 250a, 250b are attached to connecting pins 272a, 272b, respectively. The connecting pins 272a, 272b are mounted at an end of a plunger 264.

Each connecting pin 272a, 272b is in communication with a wire 274a, 274b each of which passes through the plunger 264, through an opening 278, and into an insulated line 276 which is terminated in a plug 280 which is matingly engagable with a receptacle 282 of the tissue impedance measuring device 284. The R.F. source 285 is in electrical communication with the impedance measuring device via electrical lines 283a and 283b. The source 285 and the impedance measuring device 284 are connectable in parallel in order to get realtime impedance measurement of tissue engaged between the first ends 249a, 249b of each of the electrode 250a, 250b.

The movement mechanism 236 includes a finger ring portion 252, and a thumb ring portion 254. The finger ring portion 252 is a generally flat plate having finger loops 251a, 251b formed therein. A passage 262 is formed through the finger ring portion 252 such that the longitudinal axis of the passage 262 is disposed between each finger loop and lies coplanar with the plane of each finger loop. The sleeve 256, and a cylinder 258 are partially inserted into opposite ends of the passage 262. The sleeve 256 has a passage longitudinally formed therein so as to receive the covering 244. The cylinder 258 has a passage longitudinally formed therein which is aligned with the passage of the sleeve. The plunger 264 is slidable within the passage of the cylinder 258. One end of the plunger is attached to the thumb ring portion 254, and the connection pins 272a, 272b are mounted to the other end of the plunger 264. The outer surface of the plunger 264 is visible through an access cutout 270 formed in the cylinder 258. In one embodiment, an indicator post 266 is attached to the outer surface of the plunger 264 and passes through the access cutout 270 to give an immediate visual indication of the position of the plunger 264 within the cylinder 258. In a preferred embodiment, the outer surface of the plunger 264 is scored with a plurality of indicator marks 268 to provide a visual indication of the position of the plunger 264 within the

cylinder 258, which corresponds to variable length of extension of each of the electrodes beyond their respective insulating sheaths.

In operation, the irrigation and evacuation valves, and the endoscope operate as described above. Regarding the retractable electrode assembly 202, a free hand of the surgeon is used to operate the movement mechanism 236. The surgeon's fingers are engaged within the finger ring loops and the thumb is engaged within the thumb ring portion. The thumb either pushes or pulls on the thumb ring thereby moving the attached plunger 264 into or out of the cylinder 258 and the passage 262. As the plunger 264 moves each of the first ends 249a, 249b of each of the electrodes 250a, 250b move because the connection pins 272a, 272b mounted to the plunger are attached to each of the second ends 247a, 247b of each of the electrodes 250a, 250b. Thus, as the plunger moves in the direction of the arrow A, the central portions of each of the electrodes moves within their respective insulators in the direction of the arrow B, and the first ends 249a, 249b move in the direction of the arrow C.

FIG. 21 illustrates the first end 249 of the electrode 250. The guide sheath 248 is formed with a bend at one end. The electrode 250 slides within the sheath 248 and exits the sheath 248 under the guidance of the sheath 248. The insulating cover 246 permits the easy sliding of the electrode within the sheath 248. Although a bend of 90 degrees is illustrated, it will be appreciated that a bend of any angle may be formed in the sheath 248 so as to guide the electrode 250 into a variety of angular dispositions. It should be noted that the electrode 250 is bare in the vicinity of the first end 249. A predetermined length value L, measured from the tip of the electrode to the end 255 of the insulating coat 246, represents the length of the electrode 250 that is bare or uncoated. Typical values for L range from 0 to 3 cm.

The first ends of each electrode extends beyond its respective sheath 248 by a length greater than the

predetermined extension length L in order to permit the bare electrode to penetrate a tissue portion up to the full L value. Further, the first ends of each needle electrode are separated by a predetermined separation width W (typically 0.1-2.0 cm) and each first end forms a predetermined angle θ with respect to the longitudinal axis of portion 228. In the illustrated embodiment, the angle θ is 90 degrees. Typical values for θ range between 0 and 360 degrees.

During surgical procedures, the tip end 230 of the portion 228 of the instrument 200 is brought adjacent to a target tissue area of the body cavity. The first ends of each electrode are extended beyond their respective sheaths such that each first end is embedded into the soft target tissue area thereby defining a tissue portion engaged between the adjacent first ends of each electrode. The power source is energized and R.F. energy is transmitted from one electrode to the adjacent electrode. The energy transmission causes a coagulation of the tissue portion engaged between the adjacent electrodes and ablation of the target tissue.

Using the present invention, the surgeon can predict and control the amount of tissue ablation/coagulation with greater accuracy and safety. As described above, the spacing between the two parallel first ends of each electrode remains constant at some predetermined W value, e.g. 1.0 cm. Also, the extension of the electrodes beyond the insulators at a given angle, i.e. the depth of penetration of each first ends of each electrode into the soft tissue portion, can be precisely controlled by observing the indicator marks on the plunger. Predictable and precise tissue ablation is therefore possible with the present invention because the depth of each first end of each electrode in soft tissue can be precisely controlled by the surgeon. That is, the surgeon can predict a cylindrical zone of ablation by controlling the depth of the retractable first ends into the soft tissue portion. This precise depth control enables the

surgeon to predict the zone of ablation with greater accuracy and safety than prior art non-retractable monopolar RF devices, or prior art laser delivery systems.

The cellular structure of body tissue contains water which is a conductor of electrical energy. Consequently, a portion of body tissue also has an associated resistance or impedance value. In prior art monopolar electrode devices, tissue impedance is difficult to measure. However, in the present invention, precise impedance measurement of the soft tissue in the proximity of the bipolar electrodes is possible. In the present invention, during the tissue coagulation process simultaneous measurement of the impedance of the tissue engaged between the extended first ends of the electrodes signals the completion of the tissue coagulation process and provides assurance and confirmation to the surgeon.

R.F. energy applied to the tissue engaged between the first ends of the two electrodes causes the tissue to coagulate which decreases the water content associated with the tissue. As the water content decreases the conductivity of the tissue decreases. For a constant R.F. energy, as the conductivity decreases the impedance (or resistance) associated with the tissue increases. The tissue impedance is highest when the tissue is completely coagulated, since coagulated tissue has a minimum amount of water content and current flow is blocked from one electrode to the other electrode. However, at the beginning of the ablation procedure, the tissue impedance is at a minimum because the water content of the tissue is at its highest level and the tissue is a good conductor and allows the maximum current to flow from one electrode to the other. During the ablation procedure, as the tissue coagulates the water content decreases and the tissue impedance increases. The tissue impedance measurement device 284 can be designed to transmit an variable frequency audible signal, i.e. a beeping tone, when the tissue impedance is at its lowest value. As more tissue is ablated and as the tissue impedance reaches its

highest value the audible signal decreases in frequency. In the present invention, the tissue impedance is monitored or measured on a relative basis. That is, the impedance measured or monitored is the impedance of the tissue engaged between the two needle electrodes.

FIG. 22A through 22H illustrate alternate electrode configurations. It will be noted that the preferred embodiment of the present invention includes two electrodes with a θ of 90 degrees, and a L value of 0-3 cm, and a W value of 0.1-2.0 cm. It will be appreciated that a variety of electrode configurations, with associated L, W, and θ values within the above specified ranges, are possible. However, it is generally preferable to limit the total number of electrodes to six or less.

It will be noted that in the embodiments illustrated in FIG. 22A-22C, 22G-22H, the electrodes 250 are guided by the shape of the sheath 248. That is, the electrodes can be directed towards or away from each other if the guide sheaths are angled towards or away from each other. Similarly, different θ values are possible if the sheaths are formed with the appropriately angled bends.

However, in the embodiments illustrated in FIG. 22D-22F, the sheaths are substantially straight and the electrodes themselves are bent in order to direct them in certain orientations. This feature is more clearly shown in FIG. 23 which illustrates a typical electrode having a bend formed at the location depicted by numeral 257. When the electrode is disposed within the sheath 248, the electrode 250 is in contact with at least one portion 259 of the inner surface of the sheath 248 because of the bend 257. When the electrode is extended beyond the sheath (shown in phantom lines), the electrode "flattens" within the sheath 248 while the electrode tip angles away from the sheath centerline in accordance with the bend 257 formed in the electrode.

FIG. 24 illustrates a retractable electrode surgical instrument 300 which is an alternate embodiment of the retractable electrode instrument 200 (FIG. 17). The

instrument 300 includes many of the same elements as the instrument 200. These identical elements are identified with the same reference numeral as shown in FIG. 17. In this embodiment, each electrode 250a, 250b is enclosed within a bendable guiding sheath 290a, 290b. A guide wire 293a, 293b is disposed within each sheath 290a, 290b and includes a first end 289a, 289b and a second end 291a, 291b. Each first end 289 of each guide wire 293 is attached (e.g. welded or adhesively bonded) to an inner surface of a bendable or bellows portion 292 of the sheath 290 at a location proximate the open end of the sheath 290. Each second end 291 is attached to a lever or knob 294 which is mounted to an outer surface of a housing 291. The housing 291 is similar to the housing 232 and includes communication ports for an irrigation valve and an evacuation valve (neither shown). In operation, when there is no tension on the guide wires the sheaths are straight within the conduit, i.e. θ is 0 degrees. As the surgeon pulls back on the knob or lever, the wires are tensioned and the tips of each sheath is pulled back as illustrated until a desired θ value is obtained. In this embodiment, both the L and the θ values can be adjusted by the surgeon in situ.

Although the present invention has been described above in terms of a specific embodiment, it is anticipated that alterations and modifications thereof will no doubt become apparent to those skilled in the art. It is therefore intended that the following claims be interpreted as covering all such alterations and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

CLAIMS

1. An endoscopic surgical instrument comprising:

a) a housing;

b) a single access conduit being disposed within said housing, and having a proximal end and a distal end;

c) an irrigation port formed in said housing;

d) an evacuation port formed in said housing, each of said irrigation and said evacuation ports being in fluid communication, through independent valves, with said proximal end of said single access conduit;

e) an aperture and a closure therefor, said aperture being formed in said housing, and said closure being openable to allow the ingress of microsurgical instrumentation into said proximal end of said single access conduit; and

f) RF electrode means insertable into said aperture and into said single access conduit and having a length so as to protrude beyond said distal end of said single access conduit, said RF electrode means for engaging a body tissue portion, and for simultaneously ablating said body tissue portion and measuring an impedance value associated with said body tissue portion.

2. An endoscopic surgical instrument as recited in claim 1, wherein said RF electrode means includes:

a) a first RF electrode having a distal end and a proximal end, said first RF electrode being disposed within an insulating sheath;

b) elongated guide means encasing said first RF electrode and said insulating sheath, for guiding said first RF electrode to a predetermined angle value from the longitudinal axis of said single access conduit;

c) electrode movement mechanism means, attached to said proximal end of said first RF electrode, for moving said first RF electrode within said guide means, said distal end of said first RF electrode is extendable beyond an open end of said guide means up to a predetermined

length value and engagable with and insertable into said body tissue portion;

d) energy source means, in electrical communication with said proximal end of said first RF electrode, for transmitting energy into said distal end of said first RF electrode when it is extended beyond said guide means and into said body tissue portion to ablate said body tissue portion; and

e) tissue impedance measurement means, in electrical communication with said proximal end of said first RF electrode, for measuring an impedance associated with said body tissue portion engaged with said distal end of said first RF electrode when it is extended beyond said guide means.

3. An endoscopic surgical instrument as recited in claim 2 which further includes:

a) at least one other second RF electrode having a distal end and a proximal end, said second RF electrode being disposed within a second insulating sheath;

b) elongated second guide means encasing said second RF electrode and said second insulating sheath, for guiding said second RF electrode into a second predetermined angle value from the longitudinal axis of said single access conduit said second RF electrode separated from said first RF electrode by a predetermined width value;

c) said proximal end of said second RF electrode is attached to said electrode movement mechanism means, and said distal end of said second RF electrode is extendable beyond an open end of said second guide means up to a second predetermined length value so as to be engagable with and insertable into said body tissue portion;

d) said distal end of said second RF electrode is in electrical communication with said energy source means and said tissue impedance measurement means; and

e) whereby said electrode movement mechanism means moves each of said first RF and said second RF electrodes

within each of associated guide means, and said distal ends of each of said first RF electrode and said second RF electrode is extendable beyond and retractable within each of said associated guide means, and when each of said distal ends of each RF electrode is extended beyond said associated guide means said energy source means is energized to pass electrical current from one RF electrode to the other and said tissue impedance measurement means measures the impedance of tissue engaged between each of said distal ends of each RF electrode.

4. An endoscopic surgical instrument as recited in claim 3, wherein:

a) said predetermined angle value is greater than 0 degrees and is less than 360 degrees;

b) said second predetermined angle value is greater than 0 degrees and is less than 360 degrees;

c) said predetermined length value is greater than 0 cm and is less than 3 cm;

d) said second predetermined length value is greater than 0 cm and is less than 3 cm; and

e) said predetermined width value is greater than 0.1 cm and is less than 2.0 cm.

5. An endoscopic surgical instrument as recited in claim 3, wherein:

a) said predetermined angle value is equal to said second predetermined angle value; and

b) said predetermined length value is equal to said second predetermined depth value.

6. A retractable RF electrode assembly for ablating and measuring the impedance of a body tissue portion, comprising:

a) a first RF electrode having a distal end and a proximal end, said first RF electrode being disposed within an insulating sheath;

b) elongated guide means encasing said first RF electrode and said insulating sheath, for guiding said first RF electrode into a predetermined angle value from the longitudinal axis of said single access conduit;

c) electrode movement mechanism means, attached to said proximal end of said first RF electrode, for moving said first RF electrode within said guide means, said distal end of said first RF electrode is extendable beyond an open end of said guide means up to a predetermined length value and engagable with and insertable into said body tissue portion;

d) energy source means, in electrical communication with said proximal end of said first RF electrode, for transmitting energy into said distal end of said first RF electrode when it is extended beyond said guide means and into said body tissue portion so as to ablate said body tissue portion; and

e) tissue impedance measurement means, in electrical communication with said proximal end of said first RF electrode, for measuring an impedance associated with said body tissue portion engaged with said distal end of said first RF electrode when it is extended beyond said guide means.

7. A retractable RF electrode assembly as recited in claim 6 which further includes:

a) at least one other second RF electrode having a distal end and a proximal end, said second RF electrode being disposed within a second insulating sheath;

b) elongated second guide means encasing said second RF electrode and said second insulating sheath, for guiding said second RF electrode into a second predetermined angle value from the longitudinal axis of said single access conduit, said second RF electrode separated from said first RF electrode by a predetermined width value;

c) said proximal end of said second RF electrode is attached to said electrode movement mechanism means, and

said distal end of said second RF electrode is extendable beyond an open end of said second guide means up to a second predetermined length value so as to be engagable with and insertable into said body tissue portion;

d) said proximal end of said second RF electrode is in electrical communication with said energy source means and said tissue impedance measurement means; and

e) whereby said electrode movement mechanism means moves each of said first RF and said second RF electrodes within each of associated guide means, and said distal ends of each of said first RF electrode and said second RF electrode is extendable beyond and retractable within each of said associated guide means, and when each of said distal ends of each RF electrode is extended beyond said associated guide means said energy source means is energized to pass electrical current from one RF electrode to the other and said tissue impedance measurement means measures the impedance of tissue engaged between each of said distal ends of each RF electrode.

8. A retractable RF electrode assembly as recited in claim 7, wherein:

a) said predetermined angle value is greater than 0 degrees and is less than 360 degrees;

b) said second predetermined angle value is greater than 0 degrees and is less than 360 degrees;

c) said predetermined length value is greater than 0 cm and is less than 3 cm;

d) said second predetermined length value is greater than 0 cm and is less than 3 cm; and

e) said predetermined width value is greater than 0.1 cm and is less than 2.0 cm.

9. A retractable RF electrode assembly as recited in claim 8, wherein:

a) said predetermined angle value is equal to said second predetermined angle value; and

b) said predetermined length value is equal to said second predetermined depth value.

10. An endoscopic surgical instrument as recited in claim 2, further including:
a) means for bending said guide means to vary said predetermined angle value.

11. An endoscopic surgical instrument as recited in claim 10, wherein
a) said guide means includes a bendable bellows portion disposed at a distal end of said guide means;
b) said bending means includes
i) a lever attached to said housing;
ii) a guide wire disposed within said guide means and having a first end attached to said bellows portion of said guide means; and
c) whereby actuating said lever tensions said guide wire and varies said predetermined angle value.

12. An endoscopic surgical instrument as recited in claim 3, further including:
a) means for bending each of said guide means for each of said first RF electrode and said second RF electrode to vary each of said predetermined and said second predetermined angle values.

13. An endoscopic surgical instrument as recited in claim 10, wherein
a) each of said guide means for each said first and said second RF electrodes includes a bendable bellows portion disposed at a distal end of each of said guide means;
b) each of said bending means for each of said guide means includes
i) a lever attached to said housing;

ii) a guide wire disposed within each of said guide means and having a first end attached to each said bellows portion of each of said guide means; and

c) whereby actuating said lever tensions each of said guide wires and varies each of said predetermined and said second predetermined angle value.

14. A retractable RF electrode assembly as recited in claim 6, further including:

a) means for bending said guide means to vary said predetermined angle value.

15. A retractable RF electrode assembly as recited in claim 14, wherein

a) said guide means includes a bendable bellows portion disposed at a distal end of said guide means;

b) said bending means includes

i) a lever attached to said housing;

ii) a guide wire disposed within said guide means and having a first end attached to said bellows portion of said guide means; and

c) whereby actuating said lever tensions said guide wire and varies said predetermined angle value.

16. A retractable RF electrode assembly as recited in claim 7, further including:

a) means for bending each of said guide means for each of said first RF electrode and said second RF electrode to vary each of said predetermined and said second predetermined angle values.

17. A retractable RF electrode assembly as recited in claim 16, wherein

a) each of said guide means for each said first and said second RF electrodes includes a bendable bellows portion disposed at a distal end of each of said guide means;

b) each of said bending means for each of said guide means includes

i) a lever attached to said housing;

ii) a guide wire disposed within each of said guide means and having a first end attached to each said bellows portion of each of said guide means; and

c) whereby actuating said lever tensions each of said guide wires and varies each of said predetermined and said second predetermined angle value.

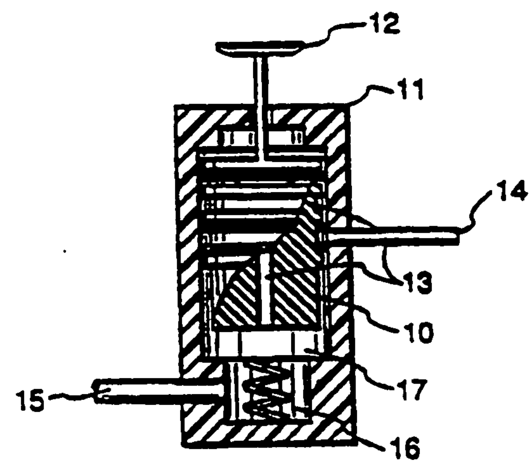
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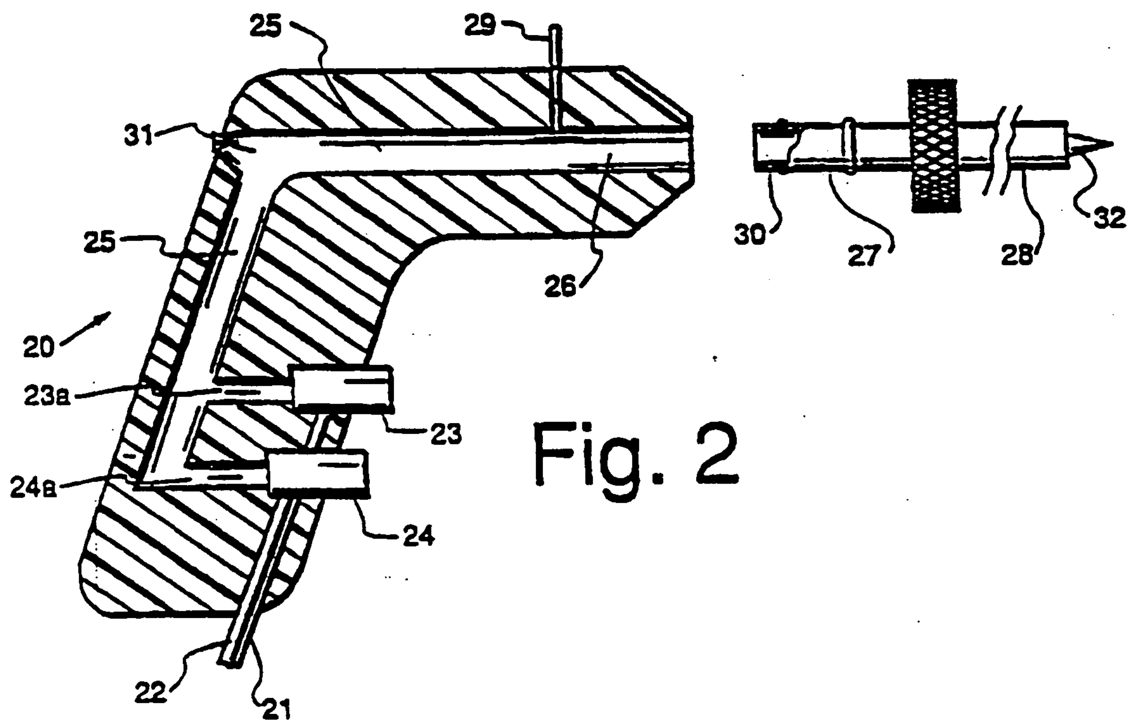
Fig. 1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26
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23a
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24a
24
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32

Fig. 2

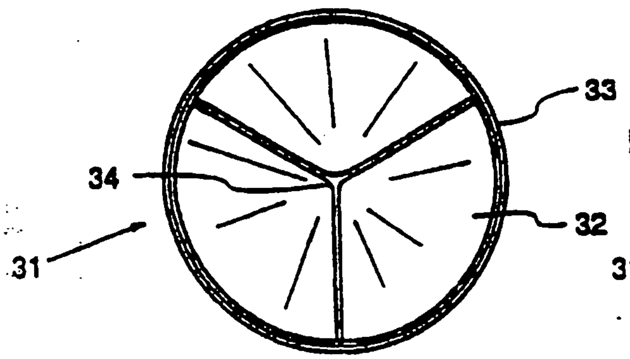

Fig. 3a

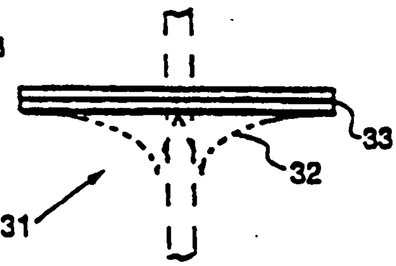

Fig. 3b

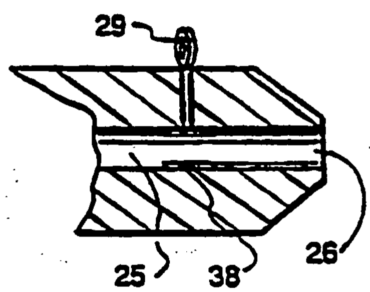

Fig. 4a

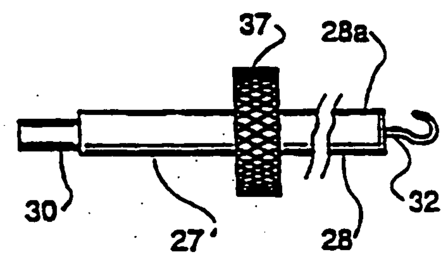

Fig. 4b

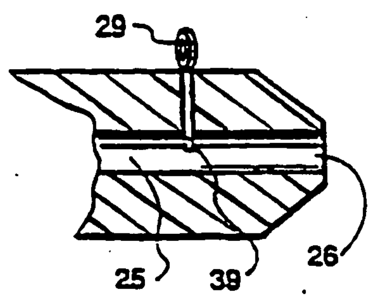

Fig. 5a

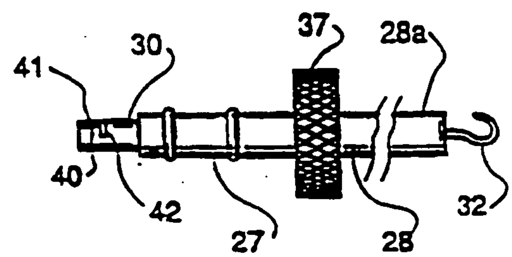

Fig. 5b

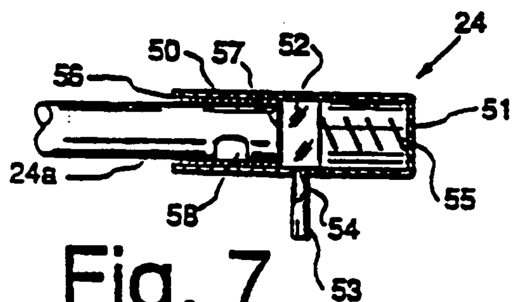

Fig. 7

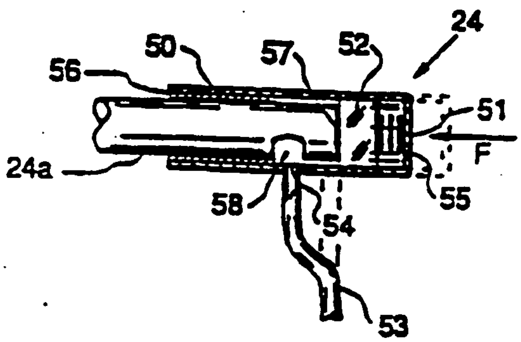

Fig. 8

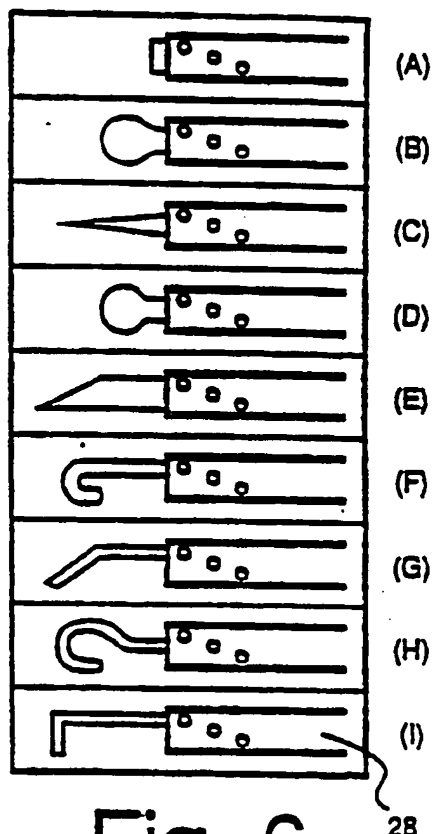

Fig. 6

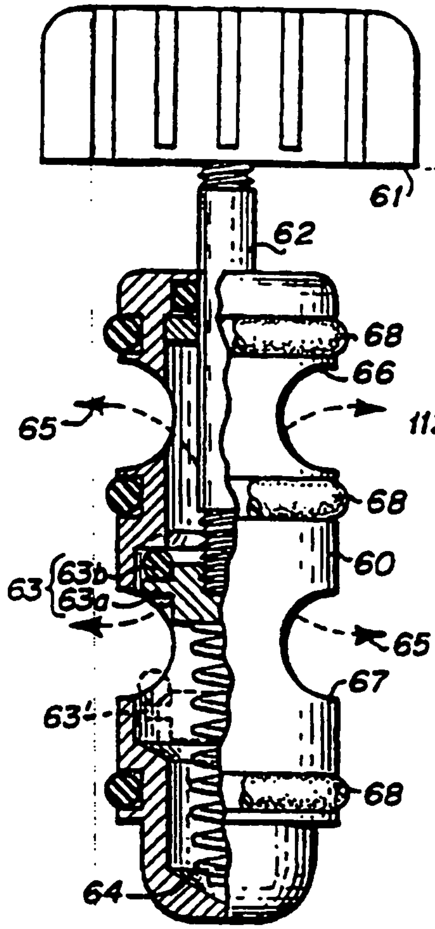

Fig_9

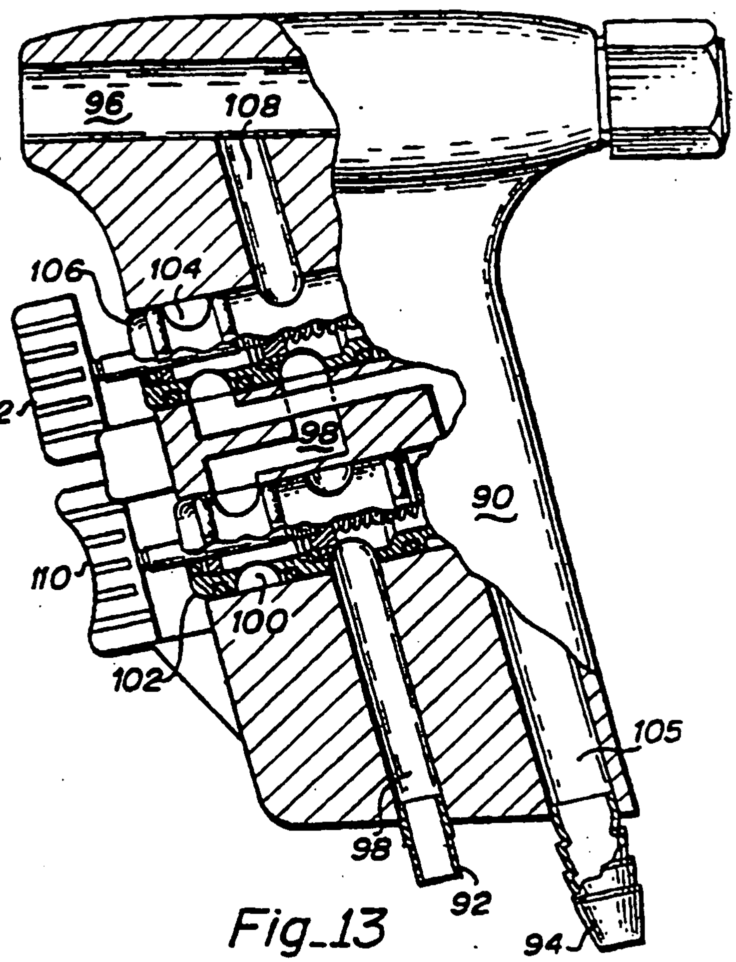

Fig_13

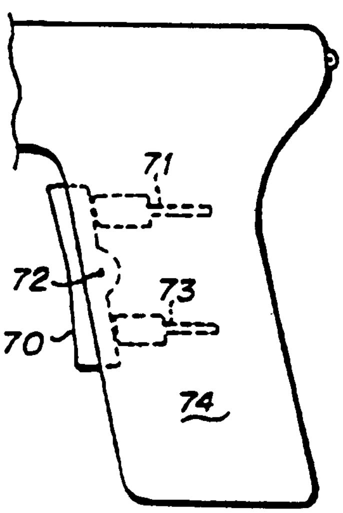

Fig_10

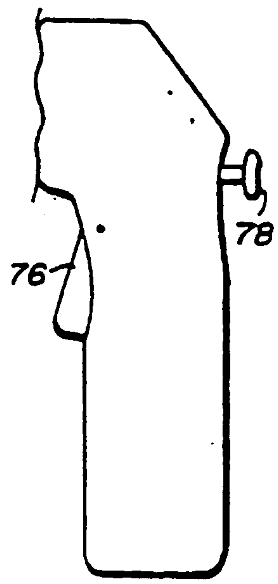

Fig_11

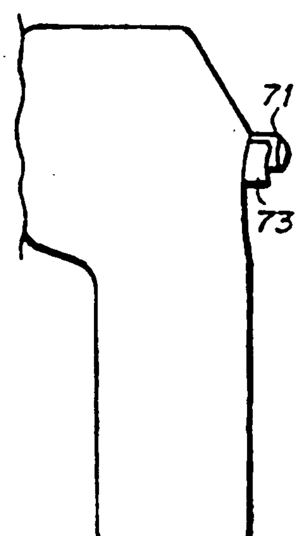

Fig_12

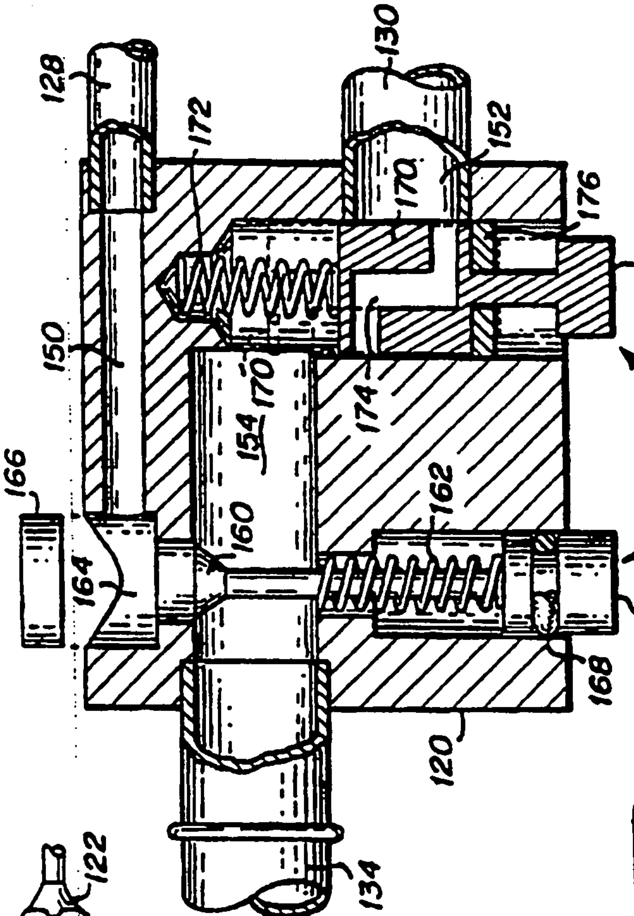

Fig.15

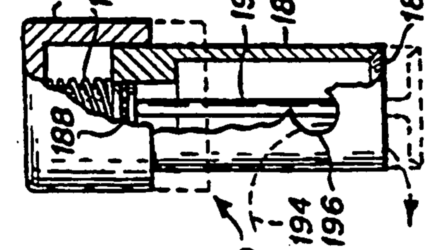

Fig.16

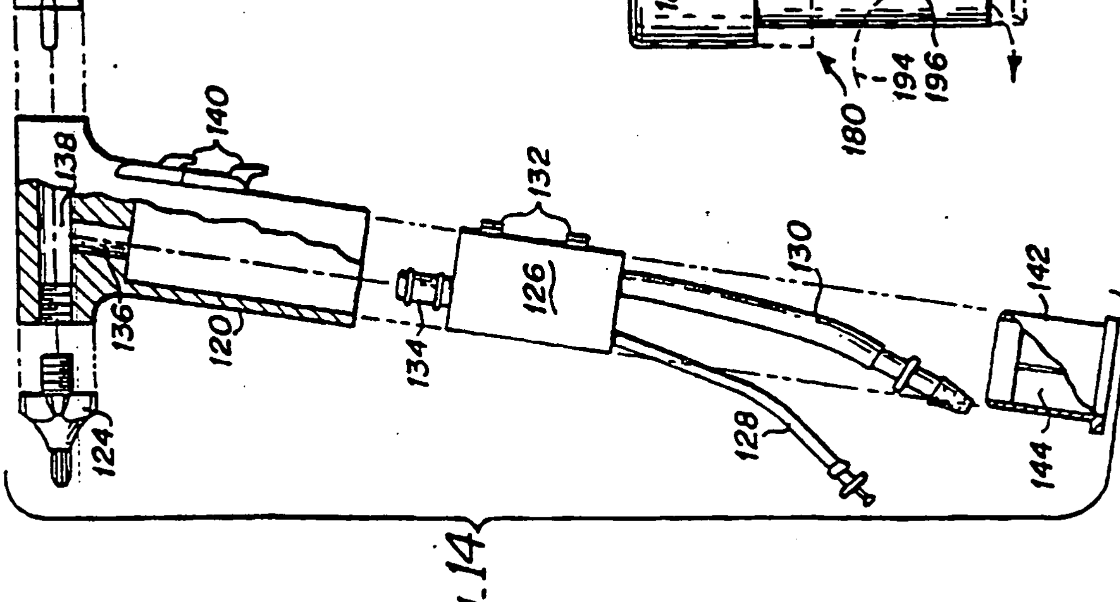

Fig.14

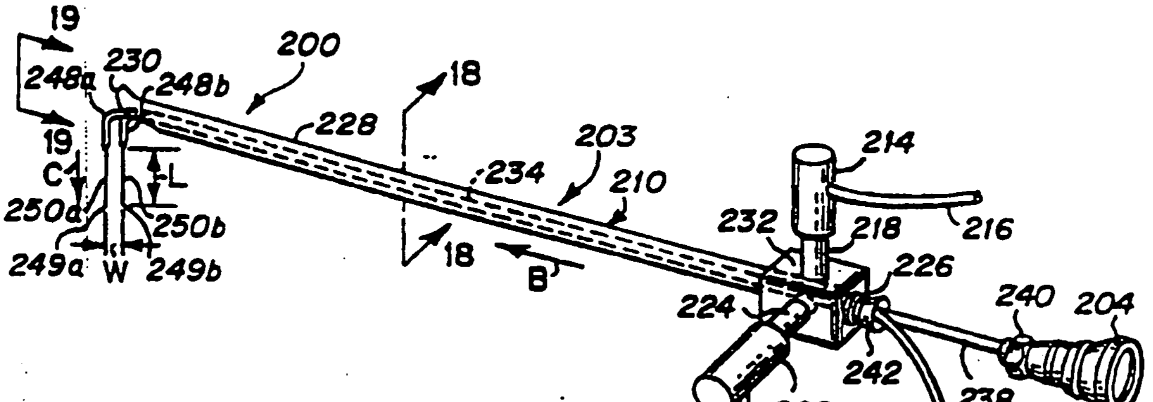
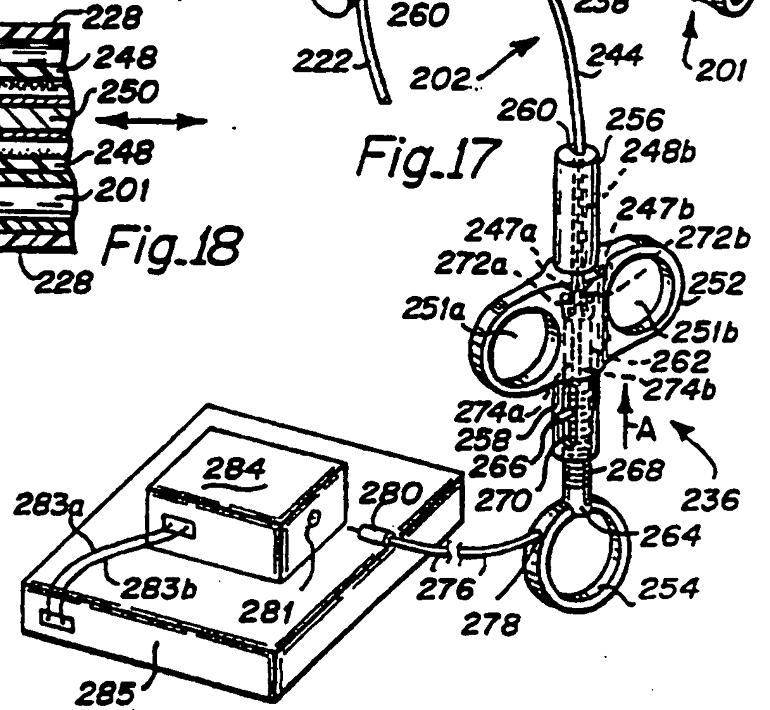

Fig_17

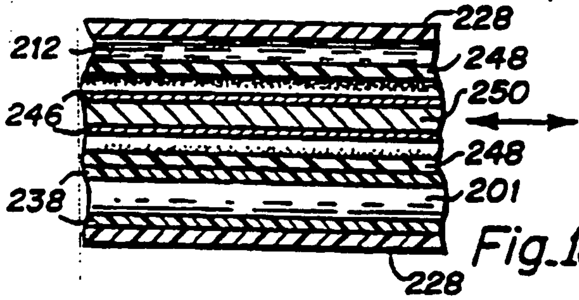

Fig_18

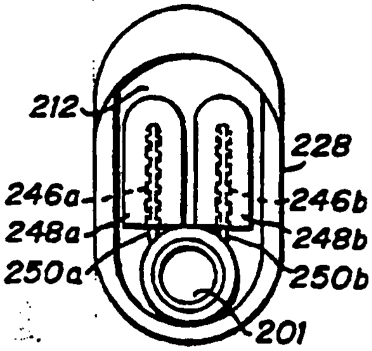

Fig_19

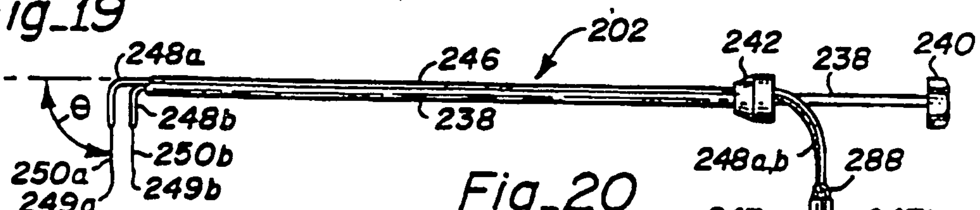
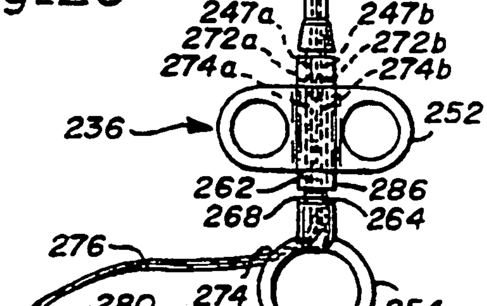

Fig_20

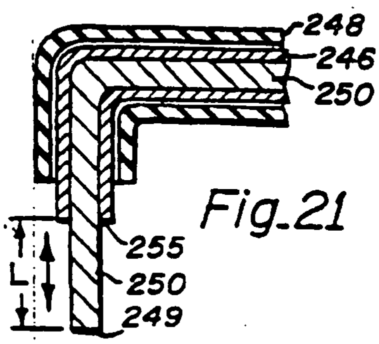

Fig_21

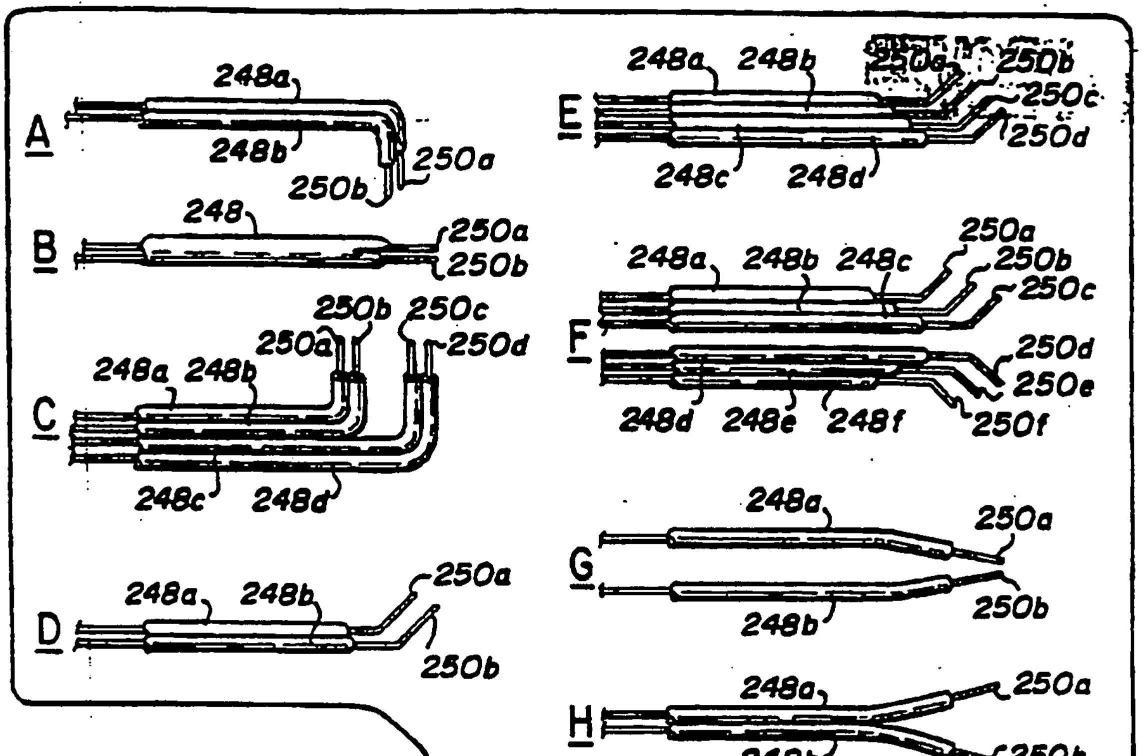

Fig_22

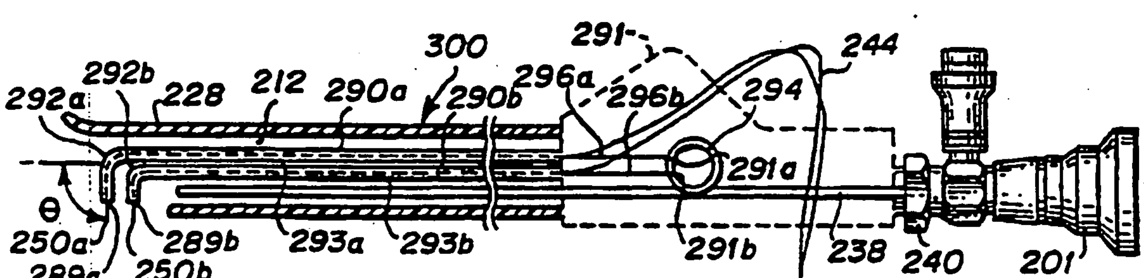

Fig_24

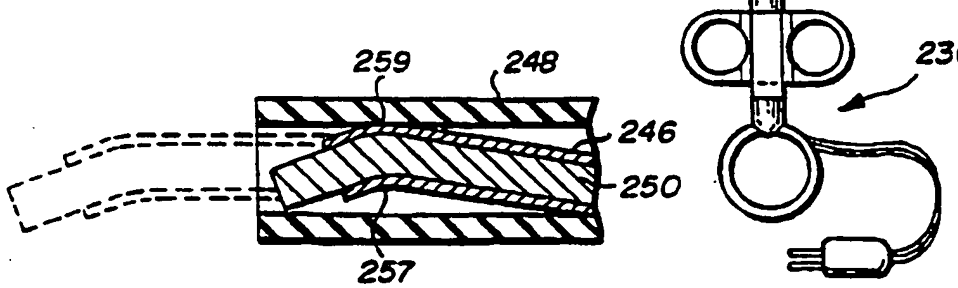

Fig_23

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US95/09152

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :A61F 5/48
US CL :128/885; 600/29; DIG.25
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 128/846, 885; 600/29; DIG. 25

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

NONE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US, A, 5,195,958 (PHILLIPS) 23 March 1993, see the entire document.	1
Y	US, A, 4,565,200 (COSMAN) 21 January 1986, see the entire document.	1
A	US, A, 5,186,714 (BOUDEREAULT ET AL.) 16 February 1993, see the entire document.	2-17
A	US, A, 4,402,310 (KIMURA) 06 September 1983, see the entire document.	2-17

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be part of particular relevance

"E" earlier document published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
10 OCTOBER 1995	26 OCT 1995
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer MICHAEL A. BROWN Telephone No. (703) 308-2682

Form PCT/ISA/210 (second sheet)(July 1992)*

TOTAL P.35